Fisheries and Oceans Canada | Pêches et Océans Canada
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Proceedings Series 2011/033 | **Compte rendu 2011/033**

Newfoundland and Labrador, Central and Arctic Regions | **Regions de Terre-Neuve et du Labrador et du Centre et de l'Arctique**

Zonal Advisory Process on Northern and Striped Shrimp

Processus de consultation scientifique zonal sur la crevette nordique et la crevette ésope

March 24 – 26, 2010
St. John's, NL

Du 24 au 26 mars 2010
St. John's, T.-N.-L.

Meeting Chairperson
Karen Dwyer

Présidente de réunion
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November 2011 | **Novembre 2011**

Canada

Foreword

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings include research recommendations, uncertainties, and the rationale for decisions made by the meeting. Proceedings also document when data, analyses or interpretations were reviewed and rejected on scientific grounds, including the reason(s) for rejection. As such, interpretations and opinions presented in this report individually may be factually incorrect or misleading, but are included to record as faithfully as possible what was considered at the meeting. No statements are to be taken as reflecting the conclusions of the meeting unless they are clearly identified as such. Moreover, further review may result in a change of conclusions where additional information was identified as relevant to the topics being considered, but not available in the timeframe of the meeting. In the rare case when there are formal dissenting views, these are also archived as Annexes to the Proceedings.

Avant-propos

Le présent compte rendu a pour but de documenter les principales activités et discussions qui ont eu lieu au cours de la réunion. Il contient des recommandations sur les recherches à effectuer, traite des incertitudes et expose les motifs ayant mené à la prise de décisions pendant la réunion. En outre, il fait état de données, d'analyses ou d'interprétations passées en revue et rejetées pour des raisons scientifiques, en donnant la raison du rejet. Bien que les interprétations et les opinions contenues dans le présent rapport puissent être inexactes ou propres à induire en erreur, elles sont quand même reproduites aussi fidèlement que possible afin de refléter les échanges tenus au cours de la réunion. Ainsi, aucune partie de ce rapport ne doit être considérée en tant que reflet des conclusions de la réunion, à moins d'indication précise en ce sens. De plus, un examen ultérieur de la question pourrait entraîner des changements aux conclusions, notamment si l'information supplémentaire pertinente, non disponible au moment de la réunion, est fournie par la suite. Finalement, dans les rares cas où des opinions divergentes sont exprimées officiellement, celles-ci sont également consignées dans les annexes du compte rendu.

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ISSN 1701-1272 (Printed / Imprimé)
ISSN 1701-1280 (Online / En ligne)

Published and available free from:
Une publication gratuite de :

Fisheries and Oceans Canada / Pêches et Océans Canada
Canadian Science Advisory Secretariat / Secrétariat canadien de consultation scientifique
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Ottawa, Ontario
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Correct citation for this publication:

DFO. 2011. Zonal Advisory Process on Northern and Striped Shrimp. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2011/033.

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SUMMARY

A meeting of the Newfoundland and Labrador/Central and Arctic Zonal Advisory Process (ZAP) on Northern and Striped Shrimp was held March 24 - 26, 2010, in St. John's, Newfoundland. Its purpose was to assess Northern Shrimp stocks in Shrimp Fishing Areas (SFAs) 4, 5 and 6 and Northern and Striped Shrimp stocks in SFAs 0, 2 and 3.

Science Advisory Reports (SARs) for SFAs 4 to 6 and SFAs 0, 2 and 3 were written and reviewed in meetings from March 29 - 31, 2010. Both include overall and SFA-by-SFA summary bullets written and reviewed at the ZAP meeting. Detailed rapporteur's notes of discussion on each working paper presented at the ZAP, in question-and-answer/comment-and-response form, were produced. This Proceedings Report includes an abstract and summary of discussion for each working paper presented, as well as progress on research recommendations from the 2008 ZAP and a list of research recommendations from this ZAP, including those being carried forward for further work.

SOMMAIRE

Une réunion du processus de consultation scientifique zonal (PCSZ) de Terre-Neuve et du Labrador/du Centre et de l'Arctique sur les crevettes nordiques et ésopes a eu lieu du 24 au 26 mars 2010, à St. John's, Terre-Neuve. Le but de cette réunion était d'évaluer les stocks de crevettes nordiques dans les zones de pêche à la crevette (ZPC) 4, 5 et 6 ainsi que les stocks de crevettes nordiques et ésopes dans les ZPC 0, 2 et 3.

On a formulé et passé en revue des avis scientifiques (AS) sur les ZPC 4 à 6 et sur les ZPC 0, 2 et 3 pendant les réunions tenues du 29 au 31 mars 2010. Les deux avis comprennent des points de sommaire pour l'ensemble des zones et pour chaque zone qui ont été rédigés et passés en revue au cours de la réunion du PCSZ. Le rapporteur a rédigé des notes détaillées sur les discussions tenues par les participants sur chaque document de travail présenté pendant le PCSZ sous la forme de questions et réponses/commentaires et réponses. Le présent compte rendu expose le résumé de chaque document de travail présenté, le sommaire des discussions connexes et les progrès accomplis au chapitre des recommandations formulées dans le cadre du PCSZ de 2008 ainsi qu'une liste des recommandations en matière de recherches formulées dans le cadre du présent PCSZ, y compris celles qui ont été reportées.

INTRODUCTION

A meeting of the Newfoundland and Labrador/Central and Arctic Zonal Advisory Process (ZAP) on Northern and Striped Shrimp was held from March 24 - 26, 2010 in St. John's to assess Northern Shrimp stocks in Shrimp Fishing Areas (SFAs) 4, 5 and 6 and Northern and Striped Shrimp stocks in SFAs 0, 2 and 3. Terms of reference, the agenda, lists of participants, and working papers presented at the meeting are provided in Appendices I through IV, respectively.

Participants included personnel of DFO Science (Newfoundland and Labrador, Central and Arctic), Fisheries and Aquaculture Management (NL, C&A and NCR), and representatives from the fishing industry, FFAW, the provincial Department of Fisheries and Aquaculture (NL and NS), the Nunavut Wildlife Management Board and Memorial University.

Open discussion and debate proceeded during and after each presentation. At the meeting, consensus was reached on overall and SFA-by-SFA summary bullets of results of the assessment. These are included in Science Advisory Reports (SARs) written and reviewed March 29 - 31, 2010.

WORKING PAPER ABSTRACTS AND DISCUSSION SUMMARIES

PHYSICAL OCEANOGRAPHY OVERVIEW

Presentation: An assessment of the physical oceanographic environment in NAFO Divs. 2J 3KLNO during 2009 by E. Colbourne, J. Craig, C. Fitzpatrick, D. Senciall, P. Stead and W. Bailey

Presenter: E. Dawe

Abstract

The North Atlantic Oscillation index for 2007-09 was slightly above normal (<0.5 standard deviation (SD)) and as a consequence, outflow of arctic air masses to the Northwest Atlantic was stronger than in warm years of 2004-06. This resulted in a broad-scale cooling of air temperatures throughout the Northwest Atlantic from West Greenland to Baffin Island to Labrador and Newfoundland relative to 2006. Sea-ice extent and duration on the Newfoundland and Labrador Shelf increased in 2009 but remained below average for the 15th consecutive year, although it was the most extensive since 1994 during the spring. As a result of these factors, local water temperatures on the Newfoundland and Labrador Shelf generally cooled compared to 2006 but remained above normal in some areas in 2009. Salinities in general on the NL Shelf, which were lower than normal throughout most of the 1990s, increased to the highest observed since the early 1990s during 2002 and have remained mostly above normal during the past 8 years. In particular, at Station 27 off St. John's, the depth-averaged annual water temperature decreased from the record high observed in 2006 to about normal in 2007 and to about 0.4 SD above normal in 2009. Annual surface temperatures at Station 27 also decreased from the 64-year record of 1.7°C (3 SD) above normal in 2006 to about 0.7 SD (0.4°C) above normal in 2009. Bottom temperatures at Station 27 were slightly below normal in 2009. From 2004-06 Station 27 bottom temperatures were >2.5 SD above normal but decreased to about 1 SD above normal in 2007-08. Upper-layer salinities at Station 27 were above normal for the 8th consecutive year. The area of the Cold-Intermediate-Layer (CIL) water mass with temperatures <0°C on the eastern Newfoundland Shelf during 2009 was below

normal (0.4 SD) for the 15th consecutive year while off southern Labrador it was above normal by 0.6 SD, the largest since 1994. Bottom temperatures on the Grand Banks (3LNO) during the spring of 2009 were above normal by <1 SD. During the fall bottom temperatures in 2J and 3K were above normal by up to 1.5 SD while in 3LNO they were about normal. The area of bottom habitat on the Grand Banks covered by <0°C water during the spring decreased from near 60% in 1991 to <5% in 2004 but increased to near-normal at about 30% in 2007-09. In conclusion, water temperatures on the Newfoundland and Labrador Shelf have decreased from the record highs of 2006 but remained above normal in most areas during 2007-08. In 2009 they decreased further with some indices showing negative anomalies. A composite climate index derived from several meteorological, ice and oceanographic time series indicate a peak in 2006 that have decreased in recent years with 2008 ranking 6th warmest and 2009 ranking 34th in 60 years of observations.

Discussion

The geostrophic component of the Labrador Current transport is generated by differential atmospheric pressure associated with the North Atlantic Oscillation (NAO). This causes a difference in elevation at the ocean surface, but, rather than flowing down slope as on land, in the ocean flow is across the slope of the surface.

A high iceberg count indicates an unusually cold spring. This index reflects iceberg calving in the far north as well as local conditions for the icebergs as they move southward. Ice cover, for example, protects the icebergs from wave action no matter how many are produced in the north. In that regard, the very limited ice cover this spring indicates the iceberg count in 2010 is likely to be low.

ECOSYSTEM

Presentation: Key aspects of the Newfoundland-Labrador Shelf Ecosystem (NAFO Divs. 2J3KLNO) by M. Koen-Alonso, F. Mowbray, P. Pepin, J. Morgan, B. Brodie, B. Vaters, D. Holloway, A. Buren, K. Dwyer, G. Stenson and K. Gilkinson

Presenter: M. Koen-Alonso

Abstract

Fisheries and Oceans Canada (DFO) has committed to developing and implementing ecosystem-based management approaches to fisheries. Although DFO is currently engaged in this development process, there is still a long way to go before fully achieving this goal. As part of this evolution, one initial step is to examine the status and trends of individual stocks within the context of the ecosystem in which they are embedded. Therefore, the goal of this presentation is to provide a synoptic overview of key aspects of the Newfoundland-Labrador shelf ecosystem (NAFO Divs. 2J3KLNO) and the changes it has experienced over the last 30 years, paying particular attention to their potential implications for northern shrimp. Specifically, this presentation examines the trends of major fish functional groups based on research vessel (RV) surveys for 2J3KL (fall survey), and 3LNO (spring survey). These analyses cover the period from the early 1980s until 2009 and are based on core strata. It also provides specific summaries of the trends of capelin, a key forage species, and harp seals, a key marine top predator. Finally, it provides a preliminary examination of the trends in diet composition in 2J3KL for cod and turbot, two key fish top predators in this system. During the late 1980s and early 1990s the fish community in the Newfoundland and Labrador large marine ecosystem

collapsed. This collapse was more dramatic in the northern regions but was observed throughout the system. It involved commercial and non-commercial species alike. Most fish functional groups showed significant declines in their biomass/abundance (BA) ratios. This generally meant a loss of large fish. Other important changes in the marine community during this period included the increasing trend of harp seals, and the build-up of shrimp. Based on acoustic surveys, capelin showed a dramatic decline in the early 1990s which was accompanied by significant changes in its biology. More recently, an increasing trend in fish biomass was observed between 2003 and 2007. Although a positive signal, biomass levels are still well below pre-collapse levels. In the last couple of years, this trend has stalled and some functional groups are showing declines; nonetheless overall fish biomass is still higher than the level observed in the 1990s. Although shrimp biomass continued increasing until the mid 2000s, it began showing negative trends in 2006-2007 and the biomass levels in 2009 showed a dramatic decline with respect to previous years. In 2007-2009 capelin showed an increased biomass level in the 3L acoustic survey in comparison with the very low levels observed in the mid 1990s. Nonetheless, its current biomass is still orders of magnitude below the ones observed in the late 1980's. The picture from bottom trawl surveys is slightly different; although they also indicate an overall increasing trend since the mid 1990s, they also showed capelin declines in 2008-2009. This difference could be related to changes in the availability of capelin to the bottom trawl gear due to variations in capelin behaviour, but this disparity still needs further examination. The fall diet of cod and turbot were examined based on detailed stomach content analysis of samples collected during DFO RV surveys and later processed in the lab, and through a preliminary reconstruction of diet composition in biomass. The diet reconstruction combined the frequency of food categories as dominant prey in the stomachs (derived from observations made on board during RV surveys) with the mean weight of these prey groups in the stomachs when they were the dominant prey (derived from the detailed stomach content analyses done in the lab). This reconstruction, besides providing an alternative source of information, allowed filling the gap in the collection of stomach contents of cod between 1996 and 2007. Diet results indicate that capelin was a dominant prey for both cod and turbot from early 1980s until the early to mid 1990s. At this time the importance of capelin dropped significantly. In recent years, shrimp has become a key prey for cod, but both cod and turbot show an increasing contribution of shrimp to the diet over time. This increasing trend starts in the late 1980s, but becomes more important in the early to mid 1990s. There is latitudinal pattern in shrimp consumption in both predators; shrimp decreases its contribution to the diet from north to south. In terms of mortality on shrimp, these results suggest that predation mortality should have increased since the mid 1990s, given the increasing shrimp contribution to diets and the positive trend in overall fish biomass, but this effect is expected to be distributed across many predators, and not exclusively linked to a single predator species (e.g. cod). Since overall fish biomass is still well below pre-collapse levels, overall prey consumption by fish is also expected to be lower than in the mid-late 1980s.

Discussion

Diet reconstruction based on called stomachs does not provide a perfect match with detailed stomach content analyses. The reconstruction is useful for an indication of the overall pattern of ecosystem change, but details provided by stomach content analysis are needed for quantification. Neither is perfect but both are useful.

This is the kind of information necessary for applying an ecosystem approach to management. At some point the ecosystem considerations that will provide the basis for a first step towards ecosystem management need to be identified. Initially, though, management must realize that the overall productivity of the system is limited. There is an upper limit to what can be removed

and this will be influenced by environmental conditions. At some point, trade offs between different fisheries such as cod and shrimp will be necessary to achieve a balance to ensure that all are able to continue to operate.

For an ecosystem to function properly there has to be special consideration for key forage species such as shrimp, capelin, arctic cod and sand lance and their role in the ecosystem. A functional ecosystem approach to management has to be precautionary and make accommodation for dependence by certain predators on certain prey when deciding on TACs. Management has to consider, for example, that increasing biomass trends in predators will lead to increasing consumption of prey and adjust accordingly.

An ecosystem approach to management is not likely unless connections between various parts of the ecosystem can be made. This process will have to evolve. The analyses presented here provide a first step to an overall picture of the ecosystem. Connecting different components is the kind of thing that would be done using multi-species models, and this is underway.

Biomass of some groundfish species which prey on shrimp has been increasing while shrimp biomass has been decreasing. Increased predator consumption is something that should be taken into account in management considerations. Diet composition expressed as % of stomach contents is quite different from consumption, which will vary with population size. At present, management is based on single species assessments and there is no basis for advising how much the shrimp TAC should be reduced. How such a TAC reduction might be calculated is not certain, but models of total consumption would be needed. Ecosystem management is largely speculative at this point, but clearly, the ecosystem must be considered when managing on a single species basis.

This research is presently focused on only two predators, cod and turbot. Estimates of their total consumption are not available, however, there are many other predators in the system. Mortality (M) is derived for a particular stock. Although consumption estimates are not available, it's assumed not to be constant. There is currently a positive trend for M in shrimp and it can be expected to be higher in future. The impact of increased predation should be reflected in total mortality estimates for shrimp.

Change in predator diet has to be considered as well. Relative abundance of prey is important. In the case of cod, the shift in diet to shrimp was opportunistic and associated with increased availability as their abundance increased. Energetically, capelin is a better food source for cod than shrimp. If shrimp becomes less available and capelin more available, cod diet will likely shift again. However, these are not simple relationships. A switch in relative abundance could also involve a shift in competition between shrimp and capelin for food.

Total prey consumption is related to total population size which has changed over time in cod and turbot. Consumption by individual fish will also vary in relation to environmental conditions – their metabolism is affected by temperature. Environmental conditions in general impact population dynamics. This study is looking at general patterns in the full assemblage of species but changes have to be fairly large scale to be detected. During the cold period of the early 1990s, for example, arctic cod were found farther south than their normal distribution and became important in the diet of cod and turbot. This sort of cold-water effect can be detected. The system seems to be driven by a strong bottom-up effect. For example, the decline in capelin appears to have been linked to a decline in euphausid populations which are important in capelin diet.

The RV survey provides the basis for evaluating large-scale changes in general ecosystem patterns. Survey signals are generally considered to be real rather than year effects if they occur over a broad area. Overall environmental factors are important, but certain components of the system affected by environmental change are not being tracked. Ecosystem research is currently exploratory in nature and management should be precautionary.

Presentation: Exploring the role of environmental and anthropogenic drivers in the trajectories of core fish species of the Newfoundland-Labrador marine community by M. Koen-Alonso, P. Pepin and F. Mowbray.

Presenter: M. Koen-Alonso

Abstract

The influence of environmental variables and fisheries impacts on the trajectories of 5 key fish species of the Newfoundland-Labrador marine community was explored using dynamic factor analysis (DFA). This analysis allows identifying common trends among several time series, as well as evaluating the impact of explanatory variables as potential drivers of the observed dynamics. The species considered for this analysis were cod, turbot, American plaice, redfish and yellowtail flounder. Time series for these species were assembled by considering geographical area (NAFO Divs 2J3KL and 3LNO), season (fall and spring) and gear employed in the research survey (Engels and Campelen). This rendered 4 sets of time-series: 2J3KL-Fall-Engels (1981-1994), 2J3KL-Fall-Campelen (1995-2008), 3LNO-Spring-Engels (1985-1995), and 3LNO-Spring-Campelen (1996-2008). The dependent variable considered for this analysis was the survey biomass index (kg/tow). The candidate drivers for the biomass of these fishes (i.e. explanatory variables) were three environmental variables and fishing impacts. The environmental variables were the North Atlantic Oscillation (NAO), sea surface temperature at Station 27 (ST27-SST, a long-term oceanographic station located near St. John's) and a Composite Environmental Index (CEI) which combines many different environmental signals (air and water temperatures, ice conditions, cold intermediate layer, NAO among others). The fishing impact was incorporated by calculating a "Fishery Index" (FI). This index was intended to measure the overall impact of fishing on the marine community and it was calculated as the ratio between the sum of all nominal catches in a given area (2J3KL or 3LNO) and the total fish biomass estimated for that area from DFO multispecies surveys (fall survey for 2J3KL and spring survey for 3LNO). Estimates of survey biomass were calculated considering core strata only. For the Campelen years, the estimate of total survey biomass also included shrimp and crab. Nominal catches were obtained from NAFO catch statistics (STATLANT 21A database). For each dataset (area, gear and time period), several DFA models were built to explore alternative combinations of common trends and explanatory variables. All time series were normalized before analysis. Models were selected using the Akaike Information Criterion (AIC). The results indicated that there were common trends in the biomass trajectories of the 5 fish species (cod, turbot, American plaice, redfish and yellowtail flounder) in all areas and time periods. Negative common trends were found from the early-mid 1980s to the mid 1990s, while positive common trends characterized the period from the mid 1990s to 2008. Fishing appears as a consistent and significant driver in the earlier period, but interestingly enough, still remains as an important driver in the more recent one, where fisheries have been targeting mainly shrimp and crab. NAO, ST27-SST and the CEI also appear as significant drivers, but their effect is less consistent than the one observed for fishing. The CEI appears as a driver in the northern region (2J3KL), while ST27-SST, and to a lesser extent NAO, appear more relevant in the Grand Bank region (3LNO).

Discussion

For the time series of RV survey results used in this modeling, only core strata, which don't include deep or inshore strata, were used. Results have been standardized as much as possible. These are exploratory analyses which show there are connections but not the types of effects or mechanisms that are linking them. There may be a broad set of mechanisms, but it's not yet known what they might be. The model is not set up to determine causality. Factors that are changing in the population at the same time ought to be affecting the rate of change, but this does not look at rate of change. Whether delayed effects improve fits needs to be explored.

The fishing index is a multi-species exploitation rate. It is an explanatory variable in all the cases presented. Compared to earlier years when groundfish dominated, in recent years this is based mostly on crab and shrimp. The model seems to be driven by the very high catches of shrimp and crab in the recent years. Fishing on crab and shrimp may be acting as an explanatory variable for noise or variance in the fish species. Possibly what this is capturing is some level of effect related to food availability. At the correlation level, there is a connection with the predator population which seems stronger in the earlier part of the time series, but the mechanisms involved are not known.

The biomass index (dependent variable) represents the whole community, but would be heavily weighted by some species. The explanatory variable is the fishery index divided by the biomass index. If the overall biomass of the system is going up and catches in the fishery are constant, the ratio of total catches to total biomass goes down and the relative impact of fishing decreases. Nevertheless, if biomass is going down along with catches, the impact of fishing can still increase.

While the analysis is not a complete picture, it highlights that there are connections in the system.

Presentation: Development of a methodology to use single beam sonar to map seabed habitat: Phase 1 – Feasibility Study by R. Gillespie

Presenter: R. Gillespie

Abstract

The objective of this study is to develop a methodology to use industry single beam sounders to collect bottom type data and compile these data to create an acoustic classification map for northern shrimp grounds off Newfoundland and Labrador. Phase 1 of the project was intended to investigate whether variations in sonar frequency, classification system algorithms, water depth, vessel speed and sea-state result in significant differences in recorded acoustic backscatter and, if so, if these differences can be normalized. Four vessels in the Northern Shrimp Research Foundation (NSRF) fleet were equipped with seabed classification systems contributed to the project by Quester Tangent Corporation of Victoria, British Columbia. Data were collected off northern Labrador during normal fishing operations. Initial results indicate acceptable correlation between water depths measured using NSRF fleet sounders and published chart data. Acoustic noise, most likely associated with bubble wash-down across the face of the sounder transducer led to problems with processing of the data to extract bottom type. A second phase of the study is being planned for summer 2011 to address these issues.

Discussion

This essentially is remote sensing. As with any remote sensing system, a signal is sent out through some medium, hits an object and is returned. The signal can be affected by many factors. It is possible to obtain the same acoustic signal from different bottom types for a variety of reasons. Interpretation of this variability now relies on a statistical clustering analysis but there are grey areas in terms of identifying bottom type. Ongoing work is trying to establish the statistical linkage between the signal and a particular bottom type property. The hope is to eventually have enough confidence in the statistics that individuals will be able to make the bottom type determination. However, this may be a matter of training people to make the same interpretation as the statistical analysis, which might not necessarily be correct.

An attempt to ground-truth the Quester system by comparison with Roxanne data has not worked well. This approach allows ballparking but doesn't solve all the problems with bottom typing. There is much variability within mud substrate, for example. It varies widely in terms of grain size, water content, sheer strength, etc. from area to area and within areas. Another approach that could be tried is to select a standard line or patch of ground that all vessels participating could transit to collect data along the same bottom under different surface conditions. This would help by providing some idea of what the acoustic signal may be measuring other than bottom type.

An Olex system, which is in use by some of the shrimp fleet operating off the northeast coast, has been acquired by the Marine Institute for use on its vessel. This will allow comparison with the Quester system. A multi-beam system is also being acquired and will be available for this project as well.

The various partners on the project intend to create an online Newfoundland and Labrador Seabed Atlas which would be password protected but likely available to industry.

NORTHERN SHRIMP ASSESSMENT OF SFAS 4, 5, 6

Presentation: Northern shrimp (*Pandalus borealis*) off Labrador and northeastern Newfoundland. Orr, D., Veitch, P.J., Skanes, K. and Sullivan, D.J. DFO Can. Sci. Advis. Sec. Res. Doc. 2011/004.

Presenter: D. Orr

Abstract

Updates of northern shrimp (*Pandalus borealis*) assessments were performed for NAFO Div. 2G, Hopedale + Cartwright Channels as well as Hawke Channel + Div. 3K, which correspond to SFAs 4, 5 and 6, respectively. Status of the resource in each area was inferred, in part, by examining trends in commercial catch, effort, catch-per-unit effort (CPUE), fishing pattern and size/sex/age composition of the catches. Fisheries independent data include an autumn multispecies research bottom trawl survey into SFAs 5 and 6 (1996 – 2009). The NSRF, in partnership with DFO, conducted a shrimp based research survey in Div. 2G (SFA 4) during each of the past five summers (2005–09). Surveys in SFAs 4-6 provide information on distribution, abundance, biomass, size/ sex composition and age structure of shrimp.

Catches increased from 22,000 t in 1994 to over 115,000 t by 2007-08 due mainly to increases in Total Allowable Catch (TAC). The TAC for the 2009-10 management year was set at 120,344

t and catches for that year equaled 80,700 t. The TAC was not taken mainly because of operational/commercial constraints.

Annual catches within SFA 6 increased from 11,000 t during 1994-96 to 80,700 t by 2007-08. The TAC for the 2009-10 management year was set at 85,725 t. Catches for the 2009-10 management year equaled 45,100 t as of April 7, 2010. Spatial distribution of the resource and large vessel fishery changed little over recent years. The spatial distribution of the small vessel fishery increased from 1998 to 2007 then decreased to 2009. The large (>500 t) vessel CPUE remained at a high level between 1995 and 2006 after which it decreased to 2009. The small vessel (<100 ft) CPUE increased to 2003, remained high until 2007 and then decreased to 2009.

Biomass and abundance indices (total, fishable and female) from fall multi-species surveys generally increased from 1997 to peak levels in 2006 but have since decreased by 50%. These indices dropped below the long term average in 2009. Recruitment indices have been variable, peaking in 2006, but have since declined to the long term average. The apparently strong 2004 year class (2006 index) did not lead to increased fishable biomass. The relationship between recruitment index and fishable biomass is uncertain.

Even though catches remained high over the period 2004 – 2007, the exploitation rate index decreased as a result of increased fishable biomass over the period 2003 – 2006.

The precautionary approach framework shows female spawning stock biomass (SSB) is presently within the cautious zone at 97% of the provisional upper stock reference point (USR).

Catches within SFA 5 (Hopedale + Cartwright Channels) increased from 15,000 t in 1997 - 2002 to around 23,000 t in 2004/05 - 2008/09. The 2009/10 TAC was set at 23,300 t and 24,900 t were taken. CPUE has been trending upward from 1992 to 2001 and has been above the long term average since 1995. Percent total area fished within SFA 5 for the large (>500 t) vessel fleet to obtain 95% of their catch increased from 5 – 11% over the period 1985 – 2006, but has since decreased to the long term mean. It is a concern that the area fished has been decreasing while the CPUE is being maintained at a high level, suggesting the resource may be becoming locally aggregated.

The SFA 5 survey fishable biomass index declined by 16% from 2006 to 2008. Fishable biomass in Cartwright Channel decreased by 40% in 2009; however, broad confidence intervals in 2009 indicate uncertainty. Recruitment in the short-term, while uncertain, appears average.

The exploitation rate index is approximately 20%, slightly above the long term mean. However, in terms of the precautionary approach framework, SSB in SFA 5 was in the healthy zone in 2008, well above the provisional USR.

Catches within SFA 4 increased from 4000 t in 1994 to 9,600 t by 2004-05. Approximately 10,700 t of shrimp were caught against a 11,320 t TAC during 2009-10. CPUE has increased since 2004/05 and is now well above the long term mean. Since 2004-05, fishery catch rates have varied about the long-term average.

The NSRF-DFO research survey biomass indices (female and fishable) have been increasing throughout the five-year time period. The recruitment index increased from 2005 to 2008 and has changed little in 2009. Exploitation rate index has decreased from 16% in 2005 to 6% in

2009. In terms of the precautionary approach framework, SSB in SFA 4 was in the healthy zone in 2009, well above the provisional USR.

In conclusion, the resource appears to have been decreasing in the south but increasing in the north.

SFA 6

Discussion

The TAC was not taken in 2009/10. This was due to commercial and operational factors that affected the fishery and not resource availability. It was a very unusual year in terms of vessels being out of service, but the main reason was low price. The various factors involved resulted in less fishing effort. Even though CPUE was down, the TAC could have been taken.

In the last assessment there was concern about the divergence that had developed after 2001 between the standardized and raw CPUE series for the large vessels. An attempt to explain this led to a new formulation for the standardization model. This reduced but did not eliminate or explain the divergence. The new model tries to eliminate possible seasonal variability in CPUE associated with changes in distribution or catchability by selecting a standard period of the fishing season to better track fishery performance. While there was very little difference in CPUE pattern between the original and proposed models for small vessels, there was a big difference for the large vessels for much of the recent period. Whereas the original model showed a substantial decline from 2006, the proposed model indicated a drop only in 2009. Nevertheless, it was proposed that the new model replace the original.

For large vessels, only data for January to June, during which catch rates are higher and most of the fishing takes place, were used in the proposed model whereas data for all months were used in the original model. The Funk Island Deep closed area data from prior to the closure were also eliminated. This clean-up of the dataset should be applied to the Hawke Channel closed area as well. It was also an important part of the earlier fishery that is no longer being fished. There were several runs of the proposed model with different parameters – the one with the best fit was selected for use in the assessment. While the data series has been cleaned up somewhat, the better fit compared to the original is mainly due to improvement in the model. The proposed model tracks the raw CPUE series better. However, the proposed model selectively removes late-season effort that is affecting CPUE. Doing so means that different portions of the total effort will be covered from year to year. Standardization should be based on the same amount of effort from the start of the season. Also, by excluding the summer-fall data from the standardization, the effect of late season depletion is removed. The data are biased by not including the full effect of fishing in each year.

CPUE is messy and questionable no matter how it is modeled, however, it was agreed that data should cover the full fishing season for both the large and small vessels. It was decided that results from the original model would be used in this assessment. Nevertheless, it was considered important to continue efforts to improve standardization of CPUE data.

It was also agreed that in future it would be useful in the assessment to present a comparison of early and late season CPUE to determine if there is a seasonal depletion effect. It is especially important to evaluate within season depletion for the recent years of decline. An aspect of fishing that should be considered in this evaluation is the extent of movement by the fleet to maintain high catch rates. This could mask within season depletion.

In the early years of the fishery, the distribution of fishing effort expanded as abundance increased. This spatial component of fishing is an important consideration in CPUE, but also indicates how much habitat is impacted by shrimp fishing, which is an important Marine Stewardship Certification (MSC) consideration. Recent changes have been difficult to interpret, but involve resource as well as economic factors. Patterns are different for the large and small vessels. While it has changed little for large vessels, consistent with the recent decline in biomass, there has been much more searching by the fleet for concentrations of shrimp than in the past. However, there has been a substantial reduction in area fished by small vessels in the past two years. Small vessels are limited to short trips and do much less searching for larger shrimp than large vessels, but the combination of increased fuel costs and low prices resulted in a significant reduction in searching for high concentrations and more fishing closer to port.

For possible use in determining provisional SSB reference points to be used in a precautionary approach framework, an attempt was made to extend the RV biomass index back to a period before the shrimp resource had started to increase. This was based on an index developed from a combination of commercial and RV survey data. A biomass index was derived from commercial catch rates for index strata selected from the survey stratification scheme. Within each stratum, commercial tows were standardized by effort, wing spread and speed and then treated as a survey unit in STRAP analysis. However, the fleet does not select fishing locations randomly, and this poses a problem with this kind of analysis of commercial data. In the analysis, strata that extend into the closed areas were excluded. However, rather than exclude whole strata, any future analyses should exclude those portions of strata within the closed areas. While the analysis showed good agreement between the fishery and RV survey indices, there was little difference between the start of the survey in 1996 and the combined index back to 1992. The analysis provided no basis to revisit the years selected from the survey to represent the productive period used in determining the provisional SSB reference points. It was agreed that the analysis did not usefully extend the RV series back beyond 1996 and won't be pursued further.

A new Delauney triangulation for use in OGMAP survey biomass estimation was presented. Deeper portions of the survey area and some areas that extended into SFA 5 were removed, but it includes the entire time series of survey stations. These changes made very little difference to the time series of survey indices and it was agreed that the new triangulation scheme should be used in future.

A recruitment index based on all animals in the 11.5 to 16 mm size range has been used mainly because that size range matches the age 2 group well. However, with fishable biomass based on >17 mm, the index is missing a group that will be recruiting to the fishable biomass in the next year. It was decided that for future assessments the recruitment index should be based on the 11.5 to 17 mm size range. This is the size range used for a recruitment index in NAFO shrimp assessments. It was also agreed that the index derived by dividing abundance of age 2 males by the female abundance that spawned each cohort should be called recruits per spawner rather than survival.

Calculation of the exploitation rate index in past assessments has been based on weight. It was proposed that it be changed to one based on numbers. It is conventional and considered more appropriate to estimate fishing mortality based on numbers rather than weights. Fisheries models generally consider removals by the fishery as numbers by size or age rather than weight. However, concerns were raised over possible implications related to TAC calculations and MSC considerations. Given there is very little difference between the two calculations and

they track each other the same way, it was decided to use calculations based on weights in this assessment. Before such a change is adopted, it was agreed that a conversion from weights at size to numbers at size based on survey length frequencies and a length-weight relationship be presented for evaluation.

For the first time, estimates of total mortality (Z), from two different methods, were presented in the assessment. There were concerns with both approaches. The aging-based method applied to fall survey catches involves comparing age 3^+ male and total female abundance with age 4^+ male and total female abundance – it gave substantially higher Z values for males than females. Growth parameters are derived from all sizes, males through females, and give higher Z values when applied to the smaller mean size of males. Males don't reach the L_∞ size. Also, males don't die but become females, so this is not a legitimate mortality for either sex. The other method involves comparison of primiparous and multiparous female abundance from observer sampling during summer when the comparison is not complicated by the presence of ovigerous females. However, the estimates were derived from counts, not weighted samples, which varied in size from year to year. The 4-year running average applied did not adequately resolve this sample-size issue. This should have been done by normalizing to obtain the same sample size in each year. Nevertheless, this method appeared to provide an acceptable basis for estimating Z, even though it applies to females only. How it might compare to mortality in males is unknown.

There is uncertainty regarding interpretation of Z values. If biomass changes over a given period, it is difficult to link changes in Z with the fishery because changes over time could relate to the relative strength of year classes going through the population. It is also uncertain what the rate should be in a healthy stock. Z has trended upwards in recent years to an annual rate of about 70%, which means that females are not available to the fishery for very long. While the estimates are within the range of values reported in the literature, it is not known if this is a level that should cause concern. However, it is considered important to track changes in Z and efforts to improve estimation should continue.

Survey indices indicate substantial decline in shrimp biomass since 2006. The cause of this decline is unknown. Fishers have noted an increased biomass of cod in their fishing area, and, to a greater extent than in the past, have been detecting masses of shrimp from 50 to 70 fathoms off bottom at certain times. They believe that shrimp move off the bottom in the presence of cod and suggest this could be a reason for reduced catches of shrimp in the survey. However, a plot of shrimp and cod catches in the survey showed no relationship between the two, suggesting that presence of cod was not responsible for low catches of shrimp in the survey.

In the recent cod assessment it was shown that cod biomass had dropped in 2009 and was highly concentrated near the 3L/3K boundary, south of the main SFA 6 shrimp concentrations. However, movements could overlap cod and shrimp to a greater extent during other seasons. Fishers are finding both cod and shrimp very patchy and highly variable in the 3L/3K area. The same problems fishers are having finding good catches could be affecting the RV survey. Even though cod abundance is down, it could still be affecting shrimp catches. Turbot is another important predator on shrimp on the traditional fishing grounds in this area.

Size frequencies from survey catches in 2009 indicate reduced abundance across all sizes of shrimp. Although increased predation might have contributed, it was considered unlikely that predators would have impacted all sizes of shrimp at the same time. It seems more likely that reduced shrimp abundance is environmentally related.

In the survey, shrimp have been caught mostly within the 2-4°C range and this was taken to represent preferred shrimp habitat. An analysis of bottom temperatures from the survey series was undertaken to determine if a reduction in the spatial extent of preferred habitat may be part of the cause of the recent decline. This was found not to be the case. However, it was considered unlikely that a relationship between temperature and preferred habitat would be that straightforward. Habitat preference is complex and involves depth and substrate as well as temperature. Although shrimp tend to be associated with a certain temperature range, this is likely a proxy for some other aspect of habitat. Nevertheless, there was good agreement between the areal habitat and fishable biomass indices up to 2006. Thereafter, the habitat index remained high while biomass dropped.

It was suggested that the decline may have been due in part to the fishery. Overfishing could have been happening in the recent period even at a 20% exploitation rate. The general relationship between biomass and yield is described as a surplus production model. The top of the dome-shaped curve is taken as maximum sustainable yield (MSY). In early years of fishing, catches less than MSY could have increased as biomass was also increasing. Catches could eventually have gone beyond the equilibrium yield, thereby exceeding MSY. If catches exceed the equilibrium yield for a given biomass, biomass will decline without necessarily seeing it in the exploitation rate initially. Shrimp populations are largely driven by environmental factors and, in the context of surplus production and MSY modeling, are inherently less stable. Nevertheless, overfishing can be a factor contributing to decline. The surplus production curve in a shrimp population could expand or shrink depending on ecosystem effects. The sustainable yield could have been much lower in recent years because of some ecosystem shift or change in population productivity.

There is no evidence that ecosystem change is the cause of the recent decline in shrimp biomass. It is likely that the ecosystem has been changing gradually for much longer, but effect on populations of very gradual change over time can be abrupt. It is possible that the ecosystem is reverting back to what it was before the groundfish collapse. The production system may be changing and management should be as cautious as possible until signals are clear.

In previous assessments it was concluded there was no observable impact of fishing at an exploitation rate of around 15% and that fishing at a 15% exploitation rate is sustainable in shrimp populations. While that may be true in periods of high production with strong recruitment, if ecological conditions have changed, it might not be applicable any longer. Clearly, the exploitation rate will increase if removals continue at the recent level and the higher exploitation rate may not be sustainable. TACs should be set in a precautionary manner considering that shrimp is a forage species.

SSB from the 2009 survey was in the cautious zone, just below the provisional USR for SFA 6 shrimp. Provisionally at least, there are harvest control rules (HCRs) in place which state that if the stock is in the cautious zone the maximum exploitation rate will be ⅔ of what it would be at MSY. That rate is unknown but HCRs contemplate that a 15% exploitation rate is conservative and could be allowed to exceed that level even if biomass is declining.

That shrimp is a forage species was included in the development of these HRCs. There is also a policy regarding management of forage species. Management advice need only indicate that SSB is in the cautious zone and how much the exploitation rate will increase at the same TAC. It was agreed that because of the complexities associated with the TAC bridging arrangement

between industry and management, the TAC that was set for the past year should be used in this calculation of next year's exploitation rate.

SFA 5

Discussion

CPUE for this area is based on large vessels only. Especially in recent years, very few small vessels operate in SFA 5. The distribution of commercial catches indicates similar fisheries in Cartwright and Hopedale Channels. There was concern that the recent downward trend in the spatial distribution of the fishery could be taken to imply shrinking resource distribution. Fishery and resource distribution should be considered together, but a comparable analysis of resource distribution was not done because the survey only covered Cartwright Channel in 2009. The reason for doing the spatial analysis of the fishery is to determine how much habitat is impacted. However, the fishery in this area is strongly influenced by ice every year and its spatial distribution is much less meaningful than in other areas.

The assessment is confounded because the RV survey is done only every other year in the northern portion of SFA 5. This is exacerbated by the current 2-year assessment schedule which puts the most recent survey of all SFA 5 two years prior to the time of the assessment. A regression analysis of survey indices for the southern portion of the area (Cartwright Channel) against those for all of SFA 5 in those years that the whole area is surveyed provides a basis for filling in the gaps when the northern portion of the area (Hopedale Channel) is not surveyed to allow interpretation of trends in survey indices for all of SFA 5. This analysis, however, includes data for Cartwright Channel in both variables. It was considered more appropriate to regress data for Cartwright Channel against those for Hopedale Channel. A regression using indices for the two channels based on the original triangulation used in OGMAP gave an $R^2 = 0.52$ and a slope similar to that for the Cartwright Channel – SFA 5 regression. Indices based on the new triangulation should be used in this regression. However, there was not sufficient confidence that this provided an acceptable basis for interpretation of trends in biomass for all of SFA 5. It was decided to report the decline in biomass from 2006 to 2008 for all of SFA 5 and the drop in Cartwright Channel in 2009 separately.

The combined commercial and survey index extends the survey index back from 1996 to 1991. The combined and survey indices track fairly well and indicate that biomass was only slightly lower during the early 1990s. This analysis provides the only basis for extending the survey biomass index back to earlier years. However, as for the same analysis for SFA 6, it was decided this provided nothing useful to revising provisional SSB reference points.

SSBs from surveys for all of SFA 5 between 1996 and 2001 were considered representative of a productive period and used as the basis for determining provisional precautionary approach reference points. SSB from the 2008 survey was in the healthy zone, well above the upper stock reference (USR). Given that the fishery index remains high as well, there is less concern about decline in survey indices in this area.

SFA 4

Discussion

In SFA 4 the fishery and survey indices are trending upward and the exploitation rate index is trending downward.

SSBs from all five surveys in the area were used as the basis for determining provisional precautionary approach reference points. SSB from the 2009 survey was in the healthy zone, well above the USR.

Z values for females are much lower than for SFAs 5 and 6. This may be because shrimp live longer as you go farther north. It might also be due to a lower level of predation, which was considered to be high in southern areas. Cod is certainly less abundant in SFA 4 than farther south. Factors contributing to shrimp mortality in the north are likely to be different than in the south.

There was a pronounced improvement in the status of shrimp resources from south to north. This was considered worth noting in the context of ecosystem changes possibly being involved in the decline of shrimp resources in the south.

NORTHERN/STRIPED SHRIMP ASSESSMENT OF SFAS 0, 2, 3

Working Paper: By-catch in the shrimp fishery from Shrimp Fishing Areas 0-3, 1979 to 2009 by T. Siferd

This paper was not presented as part of the assessment for SFAs 0-3 shrimp resources. It was tabled at the meeting in order to have it considered for upgrading to the CSAS research document series. The document provides a summary of by-catch data available from the fishery and having it in this form would serve a number of purposes in terms of responding to requests for information on species caught in these areas.

Presentation: Assessment of Northern Shrimp (*Pandalus borealis*) and Striped Shrimp (*Pandalus montagui*) in Shrimp Fishing Areas 0, 2 and 3 by T. Siferd

Presenter: T. Siferd

Abstract

An assessment of Shrimp Fishing Areas (SFA) 0, 2 and 3 was presented. The survey areas included were SFA 0, the Resolution Island Study Area (RISA), which includes SFA 2 west of 63°W and SFA 3 east of 66°W, SFA 2 Exploratory (SFA 2EX), which is SFA 2 east of 63°W, SFA 3 west of 66°W and western Hudson Strait, a new survey area, between 70°W and 78°W for both commercial species of shrimp *Pandalus borealis* and *P. montagui*. Three research surveys: 2006 and 2008 DFO surveys of SFA 0, 2007 and 2009 DFO surveys of SFA 3 and the 2005-2009 Northern Shrimp Research Foundation-DFO surveys of SFA 2EX and RISA provide the fishery independent data for this assessment. SFA 0 and SFA 3 were surveyed with the Greenland Institute of Natural Resource's research vessel Paamiut using the Cosmos 2600 trawl. SFA 2EX and RISA were sampled with the Fishery Products International's fishing vessel Cape Ballard using the Campelen 1800 trawl. Production (survey biomass and fishery data) and recruitment indices were used to assess the stocks of both species when present in an area. Commercial data from the observer program was used to determine exploitation rates and trends in catch-per-unit effort of the fishery. *P. borealis* assessed in SFA 2 and *P. montagui* assessed in SFA 2, 3, and 4 west of 63° were shown to be in the healthy zone of the precautionary approach framework.

SFA 0 – *P. borealis*

Discussion

A different method for estimation of wing spread for the Cosmos trawl used in the SFA 0 and 3 surveys was described. Indices for surveys prior to the 2008 assessment have been adjusted accordingly.

There is very little difference between survey indices of total and fishable biomass for this area. There are very few shrimp smaller than 17 mm, hence few recruitment-sized males in the catches.

There has been no recent fishing because the fleet knows there is little there. The 500 t TAC was set, without the benefit of any survey, to encourage exploratory fishing. If it were actually taken, the exploitation rate on the recent survey biomass would be very high. It should be recommended that the TAC be lowered. This should not be linked to a specific exploitation rate because that could have implications for other areas.

SFA 2 (2EX and 2CM combined) – *P. borealis*

Discussion

The Coral Protection Zone in the southern part of SFA 2 is not included in the survey. It is mostly deep water between the 500 and 750 m contours where large catches of sponges are taken and not much shrimp.

The trawl used in the survey in this area is a modified Campelen. Modifications included use of 21" instead of 14" rollers, the fishing line was floated and floats were put along the rib line. These modifications were very successful at reducing tear ups and allowed completion of the survey in Resolution Island Study Area (RISA). Survey coverage had been poor prior to the modifications. The survey in RISA is also affected by very strong tidal currents, to an extent that planning in recent years has aimed at operating there during neap tides. The modified trawl was first used in RISA in 2008 and then also in 2EX in 2009. A Linney bag is attached to the survey trawl in this area as well. It catches much smaller shrimp than the cod end. However, catchability varies on different parts of the trawl and that prevents standardization and use of these catches for a recruitment index.

There is considerable uncertainty associated with the 2005 and 2006 surveys in RISA and with the 4-year survey series for SFA 2 as a whole. 2009 is the first year that the same modified trawl was used in both 2CM (RISA-E) and 2EX. The effect of the modifications on catchability of the trawl is unknown. It was decided that the best way to move forward was with the modified trawl, recognizing there would be uncertainty associated with the change in the early years that would become less important over time. There is concern with interpretation of a trend for SFA 2 from the present survey series and uncertainty about how many additional surveys will be required before that might be possible. Nevertheless, it was agreed that present surveys provided a basis for evaluation of resource status.

The tidal currents appear to cause major shifts in distribution of shrimp in the two RISA areas (east and west). Net flow is out of Hudson Strait and along the coast of Labrador. Shrimp undertake diurnal vertical movements and are probably being moved around by these currents for many miles. Catches of both species are highly variable and sudden changes appear to be

related to movements associated with these strong currents. While movement in both directions is likely, the net effect of the strong tidal flow appears to be movement of shrimp from west to east. However, it is known that shrimp move vertically to make use of flow in different directions. They can move down to the bottom when the tide is flowing eastward and up when it is flowing westward to actually move upstream. This is speculative and the extent of such movements and mechanisms involved are unknown. Nevertheless, there appears to be considerable potential for exchange of shrimp between RISA-West and RISA-East (2 CM) and possibly adjoining areas as well.

Management of the SFA 2 shrimp resource has been extremely complicated. SFA 2 itself is divided into two separate management units (2EX and 2CM or RISA-East) and is immediately adjacent to RISA-West and the remainder of SFA 3. Superimposed on the boundaries of these management units are boundaries of three land claim areas. This complexity in turn is superimposed on populations of two different shrimp species within each of which there are unknown but apparently complex interconnections. The situation makes for considerable uncertainty with how areas should be combined for assessment. It would be a major step forward if the management structure for the whole area could be revisited and simplified to better reflect stock areas.

Provisional precautionary approach SSB reference points have been determined for the two components of SFA 2 separately as well as combined. SSB is currently in the healthy zone, well above the USR. MSC certification, including HCRs, is based on SFA 2 as a whole. To maintain consistency, an overall exploitation rate and provisional reference points based on the combined area should be reported in the SAR. There have been individual TACs for 2EX and 2CM, including in 2009/10, but MSC was set up for the combined area as a basis for going forward. The two parts of SFA 2 are being fished differently. Effort has been highly concentrated in 2CM. It is important to continue monitoring 2CM and 2EX separately, but there is an ongoing issue with spreading the fishery into 2EX where the biomass is much larger.

The terms of reference for the meeting included evaluation of the possibility of transferring quota from 2CM to 2EX. Based on the geometric mean of fishable biomass from the 2005 to 2009 surveys in 2EX, the quota for 2EX could be increased to 4700 t without exceeding a 15% exploitation rate. That would allow up to 1200 t to be transferred from 2CM to 2EX to reduce fishing pressure on 2CM where exploitation rates have been high. The 15% exploitation is recognized as a target in HRCs and is generally accepted as a benchmark for shrimp fisheries. It would be precautionary to not exceed that level until the effect can be evaluated. 2EX was originally designated exploratory to provide incentive to explore the area. There is no longer any benefit to industry to continue the exploratory designation, but the dividing line with 2CM should be maintained.

For northern SFAs it is considered important to report potential along with actual exploitation rates. The actual catch is usually much below the TAC. This flags concern about the cumulative TACs in these areas, which were originally set without any scientific basis, and the need for re-adjustment based on current information.

SFA 3 (including RISA-W survey area) – *P. borealis*

Discussion

RISA-West, with a western boundary at 66° W, was established to include a 400 t by-catch quota for *P. borealis* in the *P. montagui* fishery. It also recognized historical fishing in the area.

Subsequently, the by-catch quota was applied to all of SFA 3. There is no directed *P. borealis* fishery in SFA 3.

SFA 3 has been surveyed in 2007 and 2009 using the Cosmos trawl. The RISA-West portion was surveyed with the Campelen trawl (modified in 2008) from 2006 to 2009.

Females make up a much smaller component of the biomass in SFA 3 than farther east. Apparently, spawning occurs outside the area to the east and larvae are transported into SFA 3 on the current system. There is a shallow water area south of Resolution Island they would have to pass over to get back to the east.

SFA 2, 3 and 4 West of 63° Management Area – *P. montagui*

Discussion

Although CPUE has varied at a high level, it can not be considered representative of biomass in the area. A major problem in that regard is the mixing of two species. The preferred species is *P. borealis* and if *P. montagui* is caught, effort will shift and is continuously changing because of that. The directed CPUE designation is based on which species makes up more than 50% of the catch, but the total catch is both species combined. Major spikes in CPUE reflect changes in availability rather than biomass. East of Resolution Island the catch is primarily *P. borealis*. Catches include more *P. montagui* the father west they are taken. In the Resolution Island area, where most of the fishing takes place, the mix it is almost half and half. It increases to 80-90% *P. montagui* in SFA 3 where most of the biomass is located.

It was considered unacceptable to add estimates from different surveys in these areas, as was initially proposed, to obtain an overall minimum biomass estimate for *P. montagui*. There was major concern with big differences between the Cosmos and Campelen trawls and the lack of any basis for comparing them. There was the same concern discussed for SFA 2 with modifications to the Campelen trawl and additional concern with the Campelen surveys in SFA 2, SFA 4 and RISA being done in August while the Cosmos survey in SFA 3 is done in October. There were concerns with filling in biomass values for 2006 and 2008 when SFA 3 was not surveyed as well as with the possibility of mass population movement between SFA 3 and RISA as discussed for SFA 2. It was concluded that the addition of estimates from the various surveys could not be used as a basis for assessing the resource. The only basis for moving forward was an evaluation of the surveys in SFA 2 and 4 separately from the surveys in SFA 3.

It was decided to combine biomass for those areas covered by the Campelen trawl, which includes the small portion of SFA 4 west of 63° W, RISA, and 2EX (including the portion north of RISA). This provided a basis for a provisional reference point trajectory plot for those areas. Biomass in SFA 3 covered by the Cosmos trawl in 2007 and 2009 was treated separately. This rearrangement of survey data provided an acceptable basis for evaluating resource status.

The fishery occurs in the area between 63° W and 66° W and catch was related to biomass observed in that area in 2008 and 2009 only because of low confidence in 2006 and 2007 survey results. Observed exploitation rates based on 2008 and 2009 surveys were low at 4%. However, there is concern that the potential exploitation rate is quite high. This is because the cumulative TAC for the whole management area could be taken within this smaller area. TACs have built up over time but most are not taken. This is part of ongoing management issues for the whole area that were discussed for SFA 2.

It was concluded that current surveys provide a poor basis for ongoing monitoring and assessment of the *P. montagui* resource in these areas. It was recommended that comparative fishing be conducted in order to standardize between the Cosmos and Campelen trawls to enable combining all the areas to make better use of the data that have accumulated. Some of the concerns in this assessment relate to the possibility that part of the stock shifts between SFA 3 and RISA. This is likely to be variable and is especially a concern in years that SFA 3 is not surveyed. Annual surveys in SFA 3 would provide a better basis for assessment.

The issue of an annual survey involves *P. montagui* in SFA 2, 3, and 4 but not *P. borealis* in SFA 2. However, a concern that applies to the assessment of both species in the general area relates to several relatively small management areas. Nowhere do SFA boundaries separate discrete populations of shrimp, but when management areas are fairly large, this is not a serious resource assessment concern. In the context of precautionary approach reference points, there is greater certainty that recruitment is from SSB within the area. This is a particular concern for RISA and SFA 3 because management areas are so small and the physical oceanography is so dynamic. With so much potential for population exchange between these small areas, this concern bears directly on the quality of the assessment and the reliability of conclusions. Uncertainty will decrease with increase in spatial scale of the assessment.

Western Hudson Strait – *P. borealis* and *P. montagui*

Discussion

Western Hudson Strait is not being fished. It was surveyed for the first time in 2009. The outlook for a fishery in the area is poor and there is no plan to continue the survey.

PROGRESS ON RESEARCH RECOMMENDATIONS FROM 2008 ZAP

RESEARCH RECOMMENDATIONS FROM 2010 ZAP

SFAs 4-6

1. In estimation of the biomass index based on commercial catches, eliminate portions of strata that extend into closed areas rather than entire strata.
2. Remove data for the Hawke Channel closed area for the period prior to the closure from the CPUE time series.
3. In a further consideration of the proposal to base estimation of the exploitation rate index on abundance rather than biomass, prepare a weight-at-size to number-at-size conversion for evaluation at the same time.
4. Continue efforts to refine methods of estimating Z.
5. Continue efforts aimed at improving standardization of the CPUE time series for both the small and large vessels based on data from the full fishing season for each fleet. Include in the next assessment output from the modeling that illustrates early and late season values as well as within season patterns in CPUE.
6. In future, the recruitment index should be based on the 11.5 to 17 mm size range.
7. Further attempts to develop indices for SFA 5 in the alternate years that Hopedale Channel is not survey should be based on regressions of Cartwright Channel indices against those for Hopedale Channel in years both are surveyed.

SFAs 0-3

1. Conduct comparative fishing with the Cosmos and Campelen trawls to allow direct comparison of surveys in SFA 3 with those in SFA 2.
2. Conduct surveys in SFA 3 on an annual basis.

Recommended Research Documents

Northern Shrimp (*Pandalus borealis*) off Labrador and northeastern Newfoundland as of March 2010 by D. Orr, P. Veitch, D. Sullivan and K. Skanes

Assessment of Northern Shrimp (*Pandalus borealis*) and Striped Shrimp (*Pandalus montagui*) in Shrimp Fishing Areas 0, 2 and 3 by T. Siferd

By-catch in the shrimp fishery from Shrimp Fishing Areas 0-3, 1979 to 2009 by T. Siferd
(This paper tabled only)

Recommendation Regarding Timing of the Next Assessment

Under the current assessment schedule, SFA 6 won't be assessed until 2012. Given the magnitude of the resource decline over the past three years, along with SSB for the area being within the cautious zone according to the provisional reference points, it is recommended that the shrimp resource in SFA 6 be assessed in 2011.

There are signals of decline in SFA 5 as well. The survey is scheduled to include all of SFA 5 in 2010, and consideration should be given to including SFA 5 in a 2011 assessment. That would place the assessment for SFA 5 in spring of the year following a complete survey. A 2011 assessment for these SFAs could be a RAP.

An important consideration regarding possible return to a 2-year assessment schedule following an assessment in 2011 is that the next ZAP in 2013 would mean a 3-year gap between assessments for SFAs 0-3.That concern could be accommodated by doing a RAP in 2011 and a ZAP in 2012 under the current 2-year schedule.

APPENDIX I: TERMS OF REFERENCE

Meeting of the Newfoundland and Labrador/Central and Arctic Zonal Advisory Process (ZAP) on Northern Shrimp

Battery Hotel and Suites
100 Signal Hill Rd., St. John's, NL
March 24-26, 2010

Northwest Atlantic Fisheries Centre
80 East White Hills Road
St. John's, NL
March 29-31, 2010[1]

Meeting Chairperson: Karen Dwyer, Groundfish Section, Aquatic Resources Division, DFO, Newfoundland and Labrador Region.

TERMS OF REFERENCE

Context

The status of Northern Shrimp in Shrimp Fishing Areas (SFAs) 0, 2 to 6 (NAFO Divisions 0B to 3K) was last assessed in March 2008. The 2010 assessment also includes Striped Shrimp in SFAs 2 and 3.

The current assessment is requested by Fisheries and Aquaculture Management to provide harvest advice for 2010 and 2011.

These stocks will be assessed in a zonal advisory meeting (ZAP) every two years.

Objectives

- Overview of the environment in relation to shrimp population dynamics
- Assessment of Northern Shrimp in SFAs 4 to 6 (Divisions 2G to 3K)
- Assessment of Northern and Striped Shrimp in SFAs 0, 2, and 3
    - Given that the relative exploitation rate in SFA 2, which includes both commercial (5250t) and exploratory (3500t) areas, Resource Management (NHQ) is requesting a range of options, with associated relative exploitation rates, to allow a portion of the quota currently allocated for commercial fishing to be harvested in the exploratory area, on a discretionary basis.

[1] A second week has been planned to word craft the complete text of the SARs. Summary bullets for each stock will be agreed upon in plenary during the March 24-26, 2010 meeting. ZAP participants are encouraged to attend the second week of discussions and assist in the drafting of the SAR.

Products

Two Science Advisory Reports (SARs) will be produced during the zonal Northern Shrimp assessment: Newfoundland and Labrador Region will produce a SAR for Shrimp Fishing Area (SFA) 4 - Division 2G, SFA 5 - Hopedale and Cartwright Channels and SFA 6 - Hawke Channel + Division 3K. Central and Arctic Region will produce a SAR for SFAs 0, 2 and 3.

Associated research documents will also be produced to support these SARs. A Proceedings document will record the meeting discussions.

Participation

The following individuals with knowledge of the shrimp fishery and/or shrimp biology have been invited to participate in this meeting:

- DFO Science, Newfoundland and Labrador, Central and Arctic and NCR
- DFO Fisheries and Aquaculture Management, Newfoundland and Labrador and Central and Arctic and NCR
- Industry
- Fish, Food and Allied Workers
- Newfoundland and Labrador Provincial Department of Fisheries and Aquaculture
- Government of Nunavut
- Nunavut Wildlife Management Board
- Nunavik Marine Region Wildlife Board
- Memorial University
- Members of the public

APPENDIX II: AGENDA

Agenda: Zonal Advisory Process for Northern and Striped Shrimp in Areas 0, 2, 3, 4, 5, 6
March 24-31

Battery Hotel and Conference Centre, St. John's, NL
March 24-26th

Northwest Atlantic Fisheries Centre, White Hills
March 29-31st

Chairperson: Karen Dwyer

Wednesday, March 24

0900-0920	Preliminaries	K. Dwyer (Chair)
0920-1020	Physical Oceanography Overview	TBD
1020-1040	BREAK	
1040-1200	Ecosystem	M. Koen-Alonso
1200-1300	LUNCH	
1300-1330	Single beam sonar to map seabed habitat	R. Gillespie
1330-1500	Northern Shrimp Assessment Areas 6, 5, 4 Associated bullets for Science Advisory Report	D. Orr
1500-1520	BREAK	
1520-1700	Assessment Areas 6, 5, 4 Continued Associated bullets for Science Advisory Report	D. Orr

Thursday, March 25

0900- 1020	Assessment Areas 6, 5, 4 Continued Associated bullets for Science Advisory Report	D. Orr
1020-1100	BREAK	
1100-1200	Assessment Areas 6, 5, 4 Continued Associated bullets for Science Advisory Report	D. Orr
1200-1300	LUNCH	
1300-1500	Assessment Areas 6, 5, 4 Continued Associated bullets for Science Advisory Report	D. Orr

1500-1520	BREAK	
1520-1700	Northern/Striped Shrimp Assessment Areas 0, 2, 3	T. Siferd
Friday March 26		
0900-1020	Assessment Areas 0, 2, 3 Continued	T. Siferd
1020-1040	BREAK	
1040-1200	Assessment Areas 0, 2, 3 Continued Begin TOR on Exploitation rate in Area 2	T. Siferd
1200-1300	LUNCH	
1300- 1500	TOR on exploitation rate in Area 2 Begin Assessment bullets for Science Advisory Report (SFAs 0, 2, 3)	T. Siferd
1500-1520	BREAK	
1520-1700	Assessment bullets for Science Advisory Report (SFAs 0, 2, 3)	T. Siferd

SAR Preparation of the Zonal Advisory Process for Northern and Striped Shrimp in Areas 0, 2, 3, 4, 5, 6

Fisheries and Oceans, White Hills
March 29-31st

Chairperson: Karen Dwyer

Monday March 29

Morning Science Advisory Report (SAR) Drafting

LUNCH

Afternoon Science Advisory Report (SAR) Drafting

Tuesday March 30

Morning Science Advisory Report (SAR) Drafting

LUNCH

Afternoon Science Advisory Report (SAR) Drafting

Wednesday March 31

Morning Science Advisory Report (SAR) Drafting

LUNCH

Afternoon Science Advisory Report (SAR) Drafting

APPENDIX III: LIST OF PARTICIPANTS

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Rendell Genge	4R Shrimp	Anchor Pt	brgenge@hotmail.com	(709) 456-2654

APPENDIX IV: LIST OF WORKING PAPERS PRESENTED

Oceanographic Conditions in NAFO Divs. 2J3KLNO during 2009 by E. Colbourne, J. Craig, C. Fitzpatrick, D. Senciall, P. Stead and W. Bailey

Key aspects of the Newfoundland-Labrador Shelf Ecosystem (NAFO Divs. 2J3KLNO) by M. Koen-Alonso, F. Mowbray, P. Pepin, J. Morgan, B. Brodie, B. Vaters, D. Holloway, A. Buren, K. Dwyer, G. Stenson and K. Gilkinson

Exploring the role of environmental and anthropogenic drivers in the trajectories of core fish species of the Newfoundland-Labrador marine community by M. Koen-Alonso, P. Pepin and F. Mowbray

Development of a methodology to use single beam sonar to map seabed habitat: Phase 1 – Feasibility Study by R. Gillespie

Northern Shrimp (*Pandalus borealis*) off Labrador and northeastern Newfoundland as of March 2010 by D. Orr, P. Veitch, D. Sullivan and K. Skanes

Assessment of Northern Shrimp (*Pandalus borealis*) and Striped Shrimp (*Pandalus montagui*) in Shrimp Fishing Areas 0, 2 and 3 by T. Siferd

By-catch in the shrimp fishery from Shrimp Fishing Areas 0-3, 1979 to 2009 by T. Siferd (This paper tabled only)